DOCUMENT RESUME

ED 396 534 FL 023 877

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TITLE Typological and Topological Meaning in Diagnostic Discourse.
PUB DATE Apr 96
NOTE 15p.; Paper presented at the Annual Meeting of the American Educational Research Association (New York, NY, April 8-12, 1996).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Classroom Communication; *Clinical Diagnosis; Discourse Analysis; *Discussion (Teaching Technique); Group Dynamics; Language Usage; *Medical Education; Nonverbal Communication; Problem Solving; Professional Education; *Semantics; Videotape Recordings
IDENTIFIERS *Problem Based Learning

ABSTRACT

A 6-minute, videotaped segment of discourse in a medical school classroom problem-based learning session is analyzed for evidence of the kinds of meanings being constructed, their functions, and the linguistic, kinesic, and other means by which they are being made. Three interdependent discourse agendas are distinguished: construction, maintenance, and negotiation of group interpersonal relations; negotiated construction of thematic views of medical phenomena; and enactment of cultural and subcultural norms and formations. Nonverbal evidence is examined alongside speech. Focus of the analysis is on a perceived tension between the norms and strategies of medical diagnostic discourse, as practiced by the students, and the nature of the phenomena as they are constructed. The diagnostic approach and underlying medical terminology are viewed as typological, in semantic terms, while the natural phenomena require more topological approach. The coach/tutor is seen as taking a typological approach, and the students as bringing a topological perspective. A transcription of the discourse segment is appended. Contains 11 references. (MSE)

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ED 396 534

For "Science Discourse in a PBL Meeting: A Videoanalysis Session"
AERA 1996, New York (session 35.03)

TYPOLOGICAL AND TOPOLOGICAL MEANING IN DIAGNOSTIC DISCOURSE

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The Data

A videotape of 6 medical school students and their tutor/coach in a "Problem-Based Learning" (PBL) session (Koschmann, Myers, Feltovich, & Barrows, 1994) was provided for this discussion. I will analyze here a roughly six minute episode from this session in which the students, with occasional intervention from the coach, try to diagnose the condition of a patient whose chart information has been presented to them. They have already consulted reference text sources for possibly relevant diagnoses.

The students are seated around a rectangular table in a small seminar room. From the camera's viewpoint, there is a whiteboard with the case information along the left wall, and a very large free-standing Chart with sectional views of the human brain at the opposite end of the room. The principal speaker in the episode is Betty, who sits at the near end (head) of the table, Coach to her right. Downtable left are Norman and Jenny, at the opposite end is Lill, and downtable right beyond the Coach are Maria and an unidentified student who does not take a full turn at talk in the episode.

The Issues

These students are performing an approximation of medical diagnostic discourse in a group or collaborative sett ng. Betty in particular presents a number of hypotheses about the possible causes of the patient's symptoms, and other students react to these. The coach intervenes minimally, but attempts to steer the discussion in particular ways.

Semiotic analysis of the episode (cf. Lemke 1990, 1995) requires us to look at the kinds of meanings being constructed, their functions, and the linguistic, kinesic, and other means by which they are being made.

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Functionally, there are at least the following agendas at work:

= the construction, maintenance, and negotiation of group interpersonal relations
= the negotiated construction of thematic views of medical phenomena
= the enactment of cultural and subcultural norms and formations

These agendas are intimately interwoven and interdependent as close analysis can show. They include matters of personal dominance and authority, cultural gender roles and the discourse formations of medical theory, and institutional role relationships.

Most of the action in the episode is talk, and therefore a linguistic-semantic analysis is most revealing for what meanings are being made through this talk and how. But there is also significant use of gesture, and of the visual semiotic resources of the Chart. An integrated analysis of at least these three semiotic modalities must be attempted (for prior work on such integration see Lemke 1987; 1995a,b; in press).

My focus here is mainly on a tension I perceive in the episode between the norms and strategies of medical diagnostic discourse as practiced by these students, and encouraged by the Coach, and the nature of the phenomena as they are constructed.

The diagnostic approach, and the underlying medical terminology, for events, conditions, and anatomical objects, is fundamentally, in semantic terms, a _typological_ one. That is, it contrasts one diagnostic category with another in either/or terms, imposes a discrete terminology on continuously varying phenomena and divides even the continuous topography of the brain into bordered regions as seemingly definite as those of nation-states.

But natural phenomena, and both natural languages and their technical extensions, require us to be able to also take a more _topological_ approach to making mean with them. We need to be able to speak of quantitative and continuous variation, of multiple simultaneous non-exclusive descriptive features, of overlaps and in-betweens, of matters of degree and instability.

But in our dominant intellectual culture, a privileged position is reserved for classical logic with its narrow view of propositions as either true or false, which in turn requires typological semantic approaches to both reasoning and formal terminological systems. Sharp boundaries are required between this and that, and between true and false, contrary to the bulk of human historical experience, which shows that this is an excessively limiting way to view the world.

Natural language has evolved to provide us with resources for talking about quantity, and about degrees of certainty and uncertainty. English and most Indo-European languages, at least, do not basically treat propositions or proposals as either true or

false, either good or bad. There are about a half-dozen or so semantic properties of propositions, of which Warrantability or relative probability/certainty is just one among equals (and less frequent and elaborated than, for example, Desirability, goodness, etc.). All of these are very subtly gradable in matters of degree, with a Polarity option (binary dichotomy) available in some cases through the grammar or lexical antonyms like *true, false; good, bad* (though semantically these do not need to be mutually exclusive, except by cultural preference; for this analysis see Lemke 1989, 1992, 1996).

Natural languages have also been extended in those fields (linguistic registers) that have to deal critically with continuous variation and complex quantification. These extensions go, by and large, under the name of 'mathematics' insofar as mathematics is simply an extension of the semantics of natural language. The integration of mathematical and verbal reasoning is possible because of this historical relationship.

But far older than mathematics, and also intimately involved in its history, is visual semiotics. We humans make meaning with depictional semiotic resources, ranging from our various conventionalized pictorial resources to more abstract diagrammatic and graphical ones derived from them historically. Writing systems and mathematical symbolisms represent a special case of the general unification of visual and verbal means for making meaningful representations. Quantitative reasoning in the sciences represents perhaps the most elaborate case of integrated visual, verbal, and mathematical resources being deployed in meaning-making (see for example, Lemke, in press).

But natural language also co-evolved with human gestural and postural systems for communication, and indeed as an integral part of human social activity in all its material, ecological aspects. Ontogenetically, phylogenetically, and historically, speech and gesture share common origins (as do gesture and depiction; see Lemke 1994). Gesture allows us greater latitude and subtlety in making topological meaning relations than do the mainly typological resources of verbal semantics. Spatialization in gesture is akin to spatial representation in depiction.

In this episode we see two prime instances of the tension between typological norms of medical diagnostic discourse and the topological nature of the phenomena being discusssed and constructed. One is the imposition of typologically discrete terminology on the continuous tissue manifold of the human cortex. The other is the imposition of typological disjunctions in the mutually exclusive categories of medical diagnosis for the patient. In both cases, some more topological natural language resources, and the topological power of spatializing gestures, are used by the students to help bridge the contradiction and resolve the tension. This is what I want to examine more closely.

Locating the Hippocampus

Let's consider very briefly the first part of the episode, in which, after Betty's suggestion that the lesion causing the symptoms may be near the hippocampus, the Coach asks the students (line 19) "Where is the hippocampus?" What is worth noting here is first of all that Betty's immediate reaction is not to begin a verbal answer, but to orient to the need for "a picture" (line 20). Verbal language by itself is pretty well powerless to answer the question because its preponderantly typological resources may be very good at saying what things are, but are very limited in establishing spatial relationships, especially in three dimensions and for spatial regions of irregular shape and not readily visible location.

Norman first points to the Chart from his seat, then gets up and walks a considerable way to be able to point less ambiguously, and finally puts his finger on or almost on the chart (to minimize the visual ambiguity of parallax) and _traces_ the spatial region corresponding to the hippocampus. The information he thus conveys could not be conveyed verbally in natural language alone.

This procedure is then basically repeated by Lill for a different sectional view of the three-dimensional cortex. Semantic typology is used during the co-construction of Lill's gestural identification (*go to the crevice, that's white matter, that little loop*), but these only work _indexically_ together with the visual-kinesic-spatial resources being deployed here by the group. At one point the Coach says: (line 45-48), "That's it. That's the hippocampus, then you go over one more gyrus and you're in the _temporal_ lobe." His contrastive stress on *temporal* presses the typological approach of medical scientific terminologies. In fact, no sharp boundaries can be drawn for a 'gyrus' or a 'lobe'. The cortex is a quasi-continuous tissue manifold. Even at the microanatomical level there would not be such boundaries, but rather different cell types intermixing and overlapping in space. I am not even sure if it is absolutely possible to say for any given cell whether it belongs to the hippocampus or not in absolute terms. Nor would it necessarily be useful medically to do so.

Between True and False

Let's turn now to a more central concern of the episode and of medical diagnostic reasoning. We will see that it is related to the same basic tension described for the first part of the episode. It is not just spatial continua that are not well represented by typological semantic strategies, it is also conditions and events. When typological categories are imposed to represent phenomena, propositions made about these phenomena in terms of such categories become problematic. It is not generally possible to say what is true and what is false, and natural language recognizes this semantically by offering us a number of interpolations between polar truth and polar falsity. These have been analyzed in a number of ways in linguistics, most usefully in

my opinion by Halliday (e.g. 1985), whose analysis has been extended in various ways by Martin (1992) and myself (1996). My argument here, however, could easily be recast in the terms of other semantic theories. (Their weakness for our present purpose is that they do not relate the different semantic categories systematically to one another or to their communicative functions, though they generally agree with the analysis used here on details within each category.)

One interpolation between true and false is that of probability. The Warrantability of a proposition, as a semantic attribute of propositions, is a matter of degree and of polarity, which are normally combinable. We can assert or warrant a proposition both as more or less certain and as more or less uncertain. Another interpolation is that of frequency. The Usuality of a proposition is a semantic attribute we can construct for it telling the speaker's view of how frequent, normal, usual, expected (or rare, abnormal, unusual, surprising) it is. A not very well understood, but fairly common, extension of the semantics of Usuality (or perhaps its intersection with the semantics of Temporality), is that of Stability or Temporariness. What is not usual may also be something newly arisen, or something changed from what it has been. It may not be usual because it is only temporarily or recently the case.

In lines 140-145, Jenny says that the condition called RIND is "somewhere in between a completed stroke and TIA [another condition]" and she makes a complex gesture co-ordinating right hand with "completed stroke" and left hand with "TIA", creating a gestural space which stands here metaphorically for the topological space of possible meanings in between the typological categories of the diagnosis. Betty then quips "like ... unstable angina of the mind!" making a semantic connection between the issue of Stability or Temporariness and the continuum of possible conditions under discussion.

These conditions differ from each other, so far as is said here, in part by a _quantitative_ difference in how long symptoms persist. That quantitative difference can be represented spatially in contrast with the discreteness of the typological diagnostic categories, and the instability of the symptoms or condition contrasts with the implicit stability of the notion of that a patient 'has a condition'. The students laugh here over the tension between a norm of clean-cut right-or-wrong diagnosis and scientific definitiveness, and the fuzzy nature of the categories they must deal with.

The Coach then (line 150) presses a typological view: "Which one did he have?" and the responses begin with Maria's "he's progressing to a stroke", which emphasizes Instability through the aspect semantics of verbs. Norman comments: "A little bit of both", thus implicitly challenging the either/or semantics of typological categories, and the Coach's "which one?". Betty then begins a long discussion that turns on the Stability of the patient's condition and symptoms.

In the course of this (line 205 seq.), Norman rather forcefully frames the Instability with a contrast between "we're seeing an acute leg deficit" but "now we're seeing five-over-

five strength", and he makes hand gesture movements to accentuate this instability and temporariness. (Note that the issue of temporariness and change had been introduced initially by the Coach in line 101: "so why do the leg findings go away?")

The discussion moves on to the other main symptom, a problem with verbal language. In lines 218-223, Norman argues that the patient's speech is "screwed up", and Betty challenges this in a polar and typological way: "Is it screwed up?" Norman asserts again with a qualification "somehow" (which is a shade less definitive than the pure polar choice), and Betty concedes only in topological terms: "a little bit" and makes a gesture with her fingers held extremely close together. *It is* vs. *It isn't* has been converted again to a matter of in-between, of degree, of manner, of how much. But this is not the end of the discussion, for in her follow-up Betty invokes a whole host of Usuality resources (*occasionally, rarely, often*) and a construction of Instability (one part of the mental status exam vs. "the rest" of it).

By the time she gets to her conclusion, the resources of Warrant-by-degree are in full sway: "I don't know" (i.e. no polar assertion, no high degree of warrrantability), "I think", "would probably lean more towards" (lower degrees of probability and warrant), together with the associated Instability, "something transient that comes and goes".

Her final argument again turns on Instability (line 255 seq.), that things must have been worse at one time than they are "right now". Again her hands seem to move to show the dynamics she trying to construct, as opposed to a more static or synoptic view of a patient's definitive condition.

Conclusions

My point here is not that medical diagnostic discourse is inappropriate to the real complexity of biological and social phenomena, but that a formal emphasis on typological meaning constructions, on definitive categorizations and sharp boundaries, is necessarily in tension with the topological aspects of the phenomena. Natural language gives us some topological resources for making the kinds of meaning that are needed in such situations, and together with gestural and visual-semiotic resources, as extended by mathematics and quantitative reasoning, we are reasonably well positioned to deal with them. In this episode, when the tension is strongest, the students bring these resources to bear. Both topological and typological meaning-making strategies are necessary; purely classificatory reasoning, pure classical *reductio* and *excluded-middle* reasoning is not sufficient.

The Coach here has mainly been pressing for a typological approach, and perhaps that is at times a valuable heuristic, forcing the sort of appeal to counter-evidence that also occurs in the episode. His summary comment (line 278-81): "Some patients are vague ... don't give you the answers you wanna hear," can however be taken as marginalizing

this case rather than emphasizing how typical it is that instances do not quite fit general categories, and as putting the blame on the patient, and/or ratifying that the students should "wanna hear" more definitive answers. I am not blaming the Coach, and I may not be interpreting him generously enough. Perhaps in other episodes with this group there is more emphasis on quantitative metrics and on the impossibility of making exact mappings between continuously varying phenomena and discrete diagnostic categories. The resources the students bring to play, both semantic and gestural, seem to stand outside the official practice of the discourse, and yet they are clearly critical to making the meanings that need to be made here.

There is a great need in scientific education, especially when dealing with complex and individualized systems (e.g. local and planetary meteorology, organisms, ecosystems, etc.) to understand better the role of topological meaning in verbal semantics and reasoning, in gestural-kinesic and visual semiotics, and in the integration of mathematics with both verbal and visual reasoning. I believe that semiotic analysis offers some useful tools for doing this.

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TRANSCRIPT OF SESSION

Note: Lines cited are marked by their numbers in the original transcript in the right margin below.

|0:20:12:20|Betty: See, what it said here
n-my theory
[
|0:20:15:00|Norman: khu-hhhh
[
|0:20:15:00|Betty: about this
amnesiac dysnomic aphasia (1.0) um
it says the cause of lesion is
usually deep in temporal lobe
>just like Maria was saying<
Presumably interrupting
connections of sensory speech areas
with the hippocampal and
parahippocampal regions,
(1.02)
and I think the hippocampus is like
a lot more medial. So if it was
affecting that area it might be
the an-*terior cerebral circulation.
[
|0:20:33:00|Norman: Anterior.
|0:20:35:00|Coach: Where is the hippocampus, Line 19
|0:20:37:00|Betty: I don-do we have a picture up here on the Line 20
[
|0:20:38:00|Norman: It's right down * there, it's
the bottom of this thing.
(2.5)((Walks over to chart, points))
Right in here.
|0:20:45:00|Maria: I think it's un:der that.
[[
|0:20:45:00|Jenny: -o-It's on the inside-o-
|0:20:47:00|Norman: It's under that?
|0:20:48:00|Maria: I think it's on the inside.
|0:20:49:00|Coach: It's on the middle, (.)*middle
top.
|0:20:52:00|Maria: Sts-Ik-if you lift(produces hand
gesture) up that little temporal
lobe, it's on the inside.
[
|0:20:55:00|Coach: You can you can point it on
the middle *top.
|0:20:57:00|Maria: Middle top?
|0:20:58:00|Coach: Mm-*mmm.
(1.5)
|0:21:01:00|Maria: -o-Ye:ah its,-o-
(2.5)
|0:21:04:00|Lill: In here?(points to chart)=
|0:21:05:00|Maria =Yeah, yeah
|0:21:05:00|Norman: [yeah

|0:21:06:00|Coach: That's *it(0.2)tha:t's the hippocampus, then you go over one more gyrus and you're in the *temporal lobe. Line 45 Line 46/47 Line 48
|0:21:10:00|Maria: -o-Ri:ght-o-
|0:21:11:00|Coach: So you can also see it on the (.)frontal (1.5) on the left (.)second row, left.
[
|0:21:16:00|Norman: (left) Yeah
|0:21:21:00|Norman: Hh hh hh
|0:21:24:00|Coach: Where would it be in that section? (1.5)
|0:21:26:00|Lill: -o-Somewhere in here?-o- (1.5)
|0:21:29:00|Coach: Th:at's white matter.
|0:21:31:20|Maria: -o-In that crevice?-o-
[
|0:21:33:00|Norman: Go to the crevice there(.)that little loop, (1.0) Yeah.
|0:21:37:00|Coach: Th:at's it.
|0:21:38:00|Betty: My other theory is that if it's- if it's not a vascular lesion but a space occupying lesion it was right there((points to chart))in the area we were pointing to it would be like a posterior limb of the internal capsule which would be where the cortical spinals to the leg would be going through that part.
|0:21:53:00|Maria: Wouldn't you expect to see a lot=
[
|0:21:53:00|Norman: Khu-hh-hh ah-huh
|0:21:53:00|Maria: =greater involve:ment if you got an=
[[
|0:21:53:00|Coach: Whoa [
|0:21:58:00|Norman: Yeah
|0:21:59:00|Maria: =internal capsule?
[
|0:22:00:00|Betty: If it's
|0:22:02:00|Betty: If it's small, >I mean if< it's in the very posterior li:mb, the(.) posterior part of the posterior li:mb.(.)Because there's a-the- (2.06) somato graphic, whatever that word was,(.) arrangement of the cortical spinals as they go

through the internal capsule. If
you get way to the posterior *part
of the internal capsule, the only
thing there is motor and it's going
to be the le:g.
[
|0:22:19:00|Norman: Motor, that's true
(3.0)
|0:22:24:00|Coach: So why do the leg findings go Line 101
a:way?
|0:22:27:00|Betty: That's a good question. That kind
of goes against it being some
kind of a space occupying lesion
because you would expect it to get
progressive and then to involve
more areas. So then it's probably=
[
|0:22:35:00|Maria: Headaches,=
|0:22:35:20|Betty: =more likely
|0:22:36:00|Maria: =you would expect
|0:22:36:15|Norman: You'd expect to have headaches
|0:22:37:00|Betty: -o-Maybe, yeah.-o-
|0:22:38:00|Maria: Seizures.
|0:22:41:00|Betty: Um, it's more likely to be vascular.
|0:22:45:00|Coach: Okay
[
|0:22:46:00|Maria: -o-With his history and social-o-
[
|0:22:46:15|Coach: So
|0:22:48:00|Coach: So if it's vascular did he have a
*stroke or is he having TIAs and what
is the difference between those two
things anyway.
|0:22:53:00|Norman: With TIA's, it's like twenty-four
hours
[
|0:22:55:00|Jenny: TIA's well, a*ccording to
Harrison's TIA's um
shows some neurological damage but
it's all better in twenty-four
hours. According to Cecil's it's
all better in one hour um a hh hh
hh=
[
|0:23:09:00|Lill: (one
of 'em)
|0:23:11:00|Jenny: =and Cecil's also talked about
something called RI:ND (.)which is a
reversible ischemic(1.6)
neurological deficits?=
[
|0:23:16:00|Norman: neurological deficits
[[
|0:23:16:00|Coach: neurological deficits

|0:23:19:20|Jenny: =which is somewhere in between a completed stroke and TIA. Which, hh huh huh= Line 140
|0:23:25:00|Betty: So like angina or unstable angina of
[
|0:23:26:00|Jenny: Hh huh huh huh
|0:23:27:00|Betty: the mind. Line 145
|0:23:29:00|Jenny: =which um gets better within twenty-four to thirty-*six hours, um,(1.2)((Lips smack then mouths something like 'I don't know'))
|0:23:38:00|Coach: So which one did he ha:ve? Line 150
(1.0)
|0:23:40:00|Jenny: -o-M *m-o-
|0:23:41:00|Maria: I think he's (.)progressing to a
[
|0:23:41:10|Norman: >A little bit of both.<
|0:23:43:00|Maria: stroke.
|0:23:43:20|Betty I think it's really hard to say because I don't think we have a very good history *about exactly what's happened in the last three weeks. And I don't know how we can im*prove that.
|0:23:50:00|Jenny: We don't know how long his *leg was clumsy
(0.5)
|0:23:53:00|Betty: The leg was(clum)
[
|0:23:54:00|Norman: Yeah, we don't know how long it was clumsy, It's gone now yet he still has the *verbal problem.
(1.5)
|0:23:59:00|Betty: He doesn't have *any memory
[ ]
|0:23:59:00|Norman: (so)
|0:24:00:00|Betty: problem right now.=
=
|0:24:01:00|Norman: =Yeah, which is very o:dd.
[
|0:24:02:00|Betty: Based on our mental *status exam,
(0.3)
|0:24:04:00|Coach: -o-Hm mm-o-
|0:24:05:00|Betty: But yet his wife says that he's periodically gets goofy or >whatever it was that she said<
(3.8)
|0:24:11:00|Betty: So,
|0:24:13:00|Maria: See a stroke can develop over a period of several *days usually progressing in a step like fashion=
|0:24:18:00|Norman: =(Unless it's)

|0:24:19:00|Maria: With a deficit being added from time to time.
(1.0)
|0:24:23:00|Norman: But then you would think the leg would getting worse.
(0.5)
|0:24:25:00|Norman: ol would think.o
|0:24:26:00|Maria: We:*ll it could- I mean usually strokes are preceded by TIAs.
(0.5)
|0:24:32:00|Norman: Yeah
|0:24:32:10|Maria: So then it could've just been you know
[ ]
|0:24:32:20|Norman: Well I mean that's a yeah= =that's a risk factor *for em.
(0.7)
|0:24:35:20|Norman: The thing is that (1.0) we're seeing an- an acute leg deficit and now (.) we're seeing five over five strength. Line 205
|0:24:43:00|Maria: Hm-mm
(1.5).
|0:24:43:20|Norman: What *happened to it
[
|0:24:45:00|Betty: obviously there's no-
[
|0:24:45:00|Maria: TI*A
|0:24:47:00|Betty Uh it's most likely there was no permanent damage from what=
[
|0:24:49:00|Maria: Right.
|0:24:50:10|Betty: had happened.
=[
|0:24:50:22|Norman: But wh:y is his *speech now screwed up. Line 218
(0.7)
|0:24:53:00|Betty: Is it screwed up
|0:24:54:00|Norman: It's screwed up *somehow
|0:24:55:00|Betty: -o-a little bit-o-(hand gesture) Line 223
|0:24:56:00|Norman =<like it wasn't before>
[
|0:24:57:00|Maria: He says it's gotten worse in the last couple of days=
|0:24:59:00|Norman: =Ye:ah.
|0:24:59:00|Maria: Some:thing's gotten worse I assume it's *his speech.
[
|0:24:59:00|Betty: But yet when we--
|0:25:02:00|Betty: But yet when we actually examine him I mean occasionally not even very often >he has trouble finding the right word and we do a mental status exam<(1.3) rarely >does he

have trouble finding the right word
and he can complete the *rest of
the mental status exam with no
problems<
(1.0)
|0:25:17:00|Betty: So I don't kno:w.
(7.0) ((Norman, Jenny looking at
board.))
|0:25:22:00|Betty: I think would prob'ly lean more
towards (1.0) trans- something
transient that comes'n goes 'n we're
catching him at a fairly good
moment.
(1.5)
|0:25:30:00|Maria: Uhh
[
|0:25:32:00|Norman: Unh::::::::::::((“doubt” noise))
[ ]
|0:25:35:00|Betty: But I don't know.
(5.0)
|0:25:37:00|Betty: An' it seems like to me that Line 255
for(.) for: his wife to have been
concerned about whatever was going
on it has to be worse than it is
right now. Cause it's just- (.)
unless we just (.) don't have a
very clear picture of what he's really
like. Things just don't seem very
ba:d.
(1.0)
|0:25:51:00|Maria: Yeah see I don't think we have a
clear- [
[
|0:25:53:00|Norman: I don't see it
either. [
[
|0:25:56:00|Betty: I don't
know how we can fix that.
(5.0)
|0:26:01:00|Betty: 'Cept if we asked every question in
the book. [
[
|0:26:03:00|Coach: Hmm
((smile))
[
|0:26:04:00|Norman: ((smile))
|0:26:04:00|Betty: Hu huh huh hh.
|0:26:05:00|Coach: Some patients are vague, Line 278
|0:26:07:00|Betty: Yep.
(1.5)
|0:26:08:00|Coach: Just don't give you the answers you wanna hear. Line 281